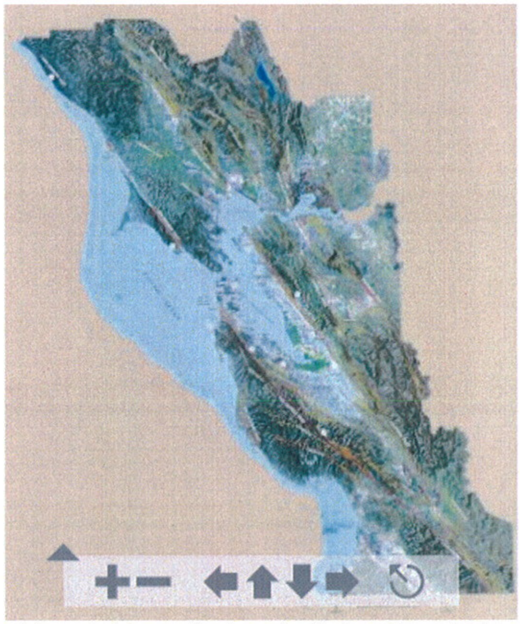
Quaternary Map of the San Francisco Bay Area

Follow the instructions in the right hand navigation pane. Related information is listed below the map. (**Note**: The following map below requires the Shockwave player to view. You can download the Shockwave player here.)



Note: This map should not be used to evaluate potential earthquake hazards. It is intended for educational and general-interest purposes only.

More detailed maps and information about earthquake hazards in the region can be obtained online from USGS, California Geological Survey , and Association of Bay Area Governments .

View Map Key in a new window

Learn more about mapping Quaternar -active faults

How to use the online map:

Use the + and - buttons to zoom in and out

Related Stories

Learn more about the labeled points on the map above.

1. Hayward - Creeping fault
2. Crystal Spring Reservoir, San Mateo County - Faulted Landscape
3. El Cerrito - Faulted Landscape
4. Sonoma County Coast - LIDAR Fault Mapping
5. Fremont and Milpitas - Faulted Quaternary Sediments
6. Fremont - Trench on the Hayward Fault
7. San Mateo County coast - A Small fault
8. Stanford University - 1906 Damage
9. San Francisco - 1906 Damage
10. Santa Rosa - 1906 Damage
11. Marin County - 1906 Surface Fault Rupture Effect
12. Santa Cruz County - 1906 Surface Fault Rupture Effect

How Was the Map of Quaternary-Active Faults Made?

This map was produced as a collaborative effort of the USGS, California Geological Survey, and geologists in the academic and private sectors, using a variety of mapping techniques, including LIDAR, interpretation of aerial photographs, and on-the-ground mapping of faults.

The map was compiled from three sources. The first was detailed new mapping of faults throughout the region. These contributions are listed below:

- Compressional faults, northeastern San Francisco Bay region—J. Unruh, William Lettis & Associates
- Concord-Green Valley Faults—B. Bryant and C. Wills, CGS
- Faults in Santa Cruz and northern Monterey County—L. Rosenberg, Tierra Geosciences
- Foothills Thrust System, Santa Clara and San Mateo Counties—D. Kennedy, Sanders & Associates
- Hayward Fault—J.J. Lienkaemper, USGS
- Northern and Peninsula segments of the San Andreas Fault—C. Prentice, USGS
- Northern Calaveras Fault—K. Kelson, William Lettis & Associates
- Rodgers Creek Fault—S. Hecker, USGS, and C. Randolph-Loar, Lachel Felice & Associates
- West Napa Fault—K. Hanson, Geomatrix (*www.geomatrix.com*), and J. Wesling, William Lettis & Associates

The second source was the map of Quaternary-active faults of California, prepared by B. Bryant, CGS, for the National Quaternary Fault Map Database.

The third source was the geologic map of the San Francisco Bay region.

USGS
science for a changing world

Earthquake Hazards Program

About the Project

History | Potential Uses | Search Strategies | Contributors | Personnel | Contact Us | References Cited

This website contains information on faults and associated folds in the United States that are believed to be sources of M>6 earthquakes during the Quaternary (the past 1,600,000 years). Maps of these geologic structures are linked to a database containing detailed descriptions and references. The database is intended to be the USGS's archive for historic and ancient earthquake sources used in current and future probabilistic seismic-hazard analyses.

Our website presents—for the first time—a single source that summarizes important information on paleoseismic (ancient earthquake) parameters. These data are compiled from thousands of journal articles, maps, theses, and other documents, as referenced herein. The database is designed to serve a variety of needs, both in terms of the user community and methods of delivering the data.

History

Starting in the early 1970s, mainly in response to national concerns about the siting of nuclear reactors, scientists needed to locate active and Quaternary faults and document their characteristics. This broad research initiative resulted in new maps and studies of Quaternary faults. State (Jennings, 1975 #4876; Witkind, 1975 #317; 1975 #320; 1975 #819; 1976 #2792; Menges and Pearthree, 1983 #2073), regional (Nakata and others, 1982 #147), and National (Howard and others, 1978 #312) maps were compiled to show the location and relative timing of major faults. These map compilations, however, did not provide much supporting data. Subsequent state-scale compilations, such as those by Johns and others, (1982 #259), Stickney and Bartholemew (1987 #242), and Hecker (1993 #642) provided some supporting database and were the first true fault compilations. The Quaternary fault and fold data for the United States has relied heavily on the past contributions, and on new efforts by State geological surveys and the U.S. Geological Survey.

The most recent effort began in 1990 in support of the International Lithosphere Program (ILP), which formed Working Group II-2. Its main objective was to compile a World Map of Active Faults (Vladimir Trifonov, chairman). In 1992, the USGS agreed to help compile maps and fault descriptions for countries in the Western Hemisphere (North, Central, and South America, as well as Australia and New Zealand). This work continues to date, with many of the compilations for Central and South America countries having been published.

In 1993, the U.S. Geological Survey began developing a database for Quaternary faults and folds for the United States in earnest, largely supported by NEHRP but with significant support from many State surveys. This product is more robust than the ILP products, mainly owing to the vast amount of data that has become available within the U.S. in the past 20-30 years and the importance that this data plays in regional and national seismic-hazard assessments (Petersen and others, 1996 #4860; Frankel and others, 1996 #5248).

The descriptions contain information on geographic, geologic, and paleoseismic parameters that are deemed critical to making geologic-based assessments of seismic hazards. In addition, we provide narrative comments that clarify, justify, or expound upon these parameters. Many of the comments in the database provide justification for the paleoseismic parameters that were chosen to characterize the faults and folds.

Reference materials

For this compilation, we have limited our compilation to synthesis of published literature relevant to the United States. Our definition of published literature includes typical sources (journals and maps), as well as M.S. theses and Ph.D. dissertations, governmental contract reports (which includes many NEHRP-sponsored studies), abstracts, and open-file (preliminary) reports. We generally do not cite unpublished field mapping, field notes, and other gray-literature reports that are not generally available to the public. The data presented in the compilation are extensively referenced using the standard USGS reference style, with the exception of attaching a unique number to each cited reference for convenience. This numeric identifier allows us to clearly cite multiple-same year publications for authors.

Potential Uses

Although seismicity maps and earthquake catalogs show the past 100 to 150 years of felt and instrumental earthquakes, many faults in the United States have return times of thousands to tens of thousands of years for surface faulting events. Clearly the short seismic record will not image all the active faults that exist. Thus, this collection of data on faults and folds that record ancient earthquakes will help augment the rather short felt and instrumental seismic record that is typical of the United States and other recently developed countries.

The database is primarily a text-based collection of descriptive data that will serve a wide and varied audience. The search capabilities described below will allow the user to sort the data on a variety of fields (geographic, structural, time of movement, slip rate, etc.). The basic strategy in classifying the data has been to create a variety of bins (categories) to characterize these potential seismic sources in terms of their activity rates. You can sort the data by time of most recent movement (4 inclusive categories) or slip rate (4 exclusive categories). For example, if you want to see the youngest and most active prehistoric faults, one would search for faults that have moved in the past 15,000 years at rates>5 mm/yr.

Search strategies

The database has two search forms. The **Quick Search** form is very simple with only four search options available. Two options permit searches on *Name* and *Number* of a particular fault or fold. The other two options permit geographic searches by *State* and *County*.

The **Advanced Search** form can be used to further limit the search results. The Advanced Search form allows queries on the above four parameters and on geographic options, paleoseismic characteristics, and structural characteristics. The additional geographic search options are *AMS sheet* and *physiographic province*. The searchable paleoseismic characteristics include *time* of most recent prehistoric deformation, *year* of historic deformation, and *slip-rate* category. Searchable structural characteristics include *length* of fault or fault section, *average strike* of fault or fault section, *sense of movement*, and *dip direction* of the fault.

Complete as few or many of the fields as you wish. The narrower the search; the quicker the results will be available. If you expect that your search will result in a large number of results (more than 40), you can reduce the amount of time to obtain those results by limiting the number of results on each page at the bottom of the search form.

There are three basic types of search fields: those with (1) pull-down menus, (2) text, and (3) numeric. The fields having pull-down menus provide all available options. Text fields like Name, County, and AMS sheet are not case sensitive and will search on partial words. The numeric fields such as Number, Year of historic deformation, Length, and Average strike should only contain numeric expressions. The Number field will not find specific sections (a, b, c, etc.); instead search for the fault number only. The Year of historic deformation requires a four-digit year in each field; use values that would encompass the historical record (such as 1600 and 2005) to search for all entries in this field. The length and average-strike searches will yield all records with inclusive values and show all sections of a fault if one of those sections has the desired value

Many modern web browsers have an "auto complete" function that will fill in data fields based on the first several characters or digits from your browser profile. You should turn off this feature prior to conducting searches that require entering characters or digits.

Contributors

Compilers and cooperators are listed on the web page. Compilers are those who described faults or folds for the database. Cooperators are those who assisted with the development of digital fault data (traces), the database structure, or the geographical information system (GIS) interfaces.

Personnel

The project coordinator is Michael Machette (USGS). The database structure was created by Kathy Haller (USGS) and an early version of the web interface and search engines were created by Larry Mayer (formerly of the University of Miami at Oxford, Ohio). The GIS data was engineered and maintained by Richard Dart (USGS). The fault and fold traces were digitized mainly by Richard Dart, with help from Dean Hancock*. Static maps were made by Susan Rhea (USGS), Richard Dart, and Damon Sather*. The graphic web browser and ArcIMS module (still under development) were created by Susan Rhea, Damon Sather*, Karen Morgan*, and John Cox*. Much of the reference database and entry of data into the text database was done with the able assistance of Philly Morrow, Meredith Frey, and Kelli Clark (*, all former student interns or contractors to the USGS).

Contact us

For more information about this database, or to comment or contribute information on specific structures, please contact us. This email address is monitored regularly by our staff.

References Cited

#5248 Frankel, A.D., Mueller, C.S., Barnhard, T.P., Perkins, D.M., Leyendecker, E.V., Dickman, N., Hanson, S.L., and Hopper, M.G., 1996, National seismic-hazard maps—Documentation June 1996: U.S. Geological Survey Open-File Report 96-0532, 110 p.

#642 Hecker, S., 1993, Quaternary tectonics of Utah with emphasis on earthquake-hazard characterization: Utah Geological Survey Bulletin 127, 157 p., 6 pls., scale 1:500,000.

#312 Howard, K.A., Aaron, J.M., Brabb, E.E., Brock, M.R., Gower, H.D., Hunt, S.J., Milton, D.J., Muehlberger, W.R., Nakata, J.K., Plafker, G., Prowell, D.C., Wallace, R.E., and Witkind, I.J., 1978, Preliminary map of young faults in the United States as a guide to possible fault activity: U.S. Geological Survey Miscellaneous Field Studies Map MF-916, 2 sheets, scale 1:5,000,000.

#4876 Jennings, C.W., 1975, Fault map of California with locations of volcanoes, thermal springs, and thermal wells: California Division of Mines and Geology California Geologic Data Map 1, scale 1:750,000.

#259 Johns, W.M., Straw, W.T., Bergantino, R.N., Dresser, H.W., Hendrix, T.E., McClernan, H.G., Palmquist, J.C., and Schmidt, C.J., 1982, Neotectonic features of southern Montana east of 112°30' west longitude: Montana Bureau of Mines and Geology Open-File Report 91, 79 p., 2 sheets.

#2073 Menges, C.M., and Pearthree, P.A., 1983, Map of neotectonic (latest Pliocene-Quaternary) deformation in Arizona: Arizona Bureau of Geology Mineral Technology Open-File Report 83-22, 48 p., scale 1:500,000.

#147 Nakata, J.K., Wentworth, C.M., and Machette, M.N., 1982, Quaternary fault map of the Basin and Range and Rio Grande rift provinces, Western United States: U.S. Geological Survey Open-File Report 82-579, 2 sheets, scale 1:2,500,000.

#4860 Petersen, M.D., Bryant, W.A., Cramer, C.H., Cao, T., Reichle, M.S., Frankel, A.D., Lienkaemper, J.J., McCrory, P.A., and Schwartz, D.P., 1996, Probabilistic seismic hazard assessment for the State of California: California Department of Conservation, Division of Mines and Geology Open-File Report 96-08 (also U.S. Geological Open-File Report 96-706), 33 p.

#242 Stickney, M.C., and Bartholomew, M.J., 1987, Preliminary map of late Quaternary faults in western Montana: Montana Bureau of Mines and Geology Open-File Report 186, 1 pl., scale 1:500,000.

#317 Witkind, I.J., 1975, Preliminary map showing known and suspected active faults in western Montana: U.S. Geological Survey Open-File Report 75-285, 36 p. pamphlet, 1 sheet, scale 1:500,000.

#320 Witkind, I.J., 1975, Preliminary map showing known and suspected active faults in Idaho: U.S. Geological Survey Open-File Report 75-278, 71 p. pamphlet, 1 sheet, scale 1:500,000.

#819 Witkind, I.J., 1975, Preliminary map showing known and suspected active faults in Wyoming: U.S. Geological Survey Open-File Report 75-279, 35 p. pamphlet, 1 sheet, scale 1:500,000.

#2792 Witkind, I.J., 1976, Preliminary map showing known and suspected active faults in Colorado: U.S. Geological Survey Open-File Report 76-154, scale 1:500,000.

SFBR Home
Quaternary Menu
Introduction
Maps
About Quaternary Faults
Downloads
Links

Quaternary Links and Helpful Resources

Links to sites related to Quaternary-active faults, earthquakes, and other hazards in the San Francisco Bay region.

San Francisco Bay Region Geology Website
This older website provides access to additional resources, maps, and information about the regional geology of the San Francisco Bay region.

Fault Mapping

- USGS Quaternary Fault Map Database
- California Geological Survey Regulatory Zone Mapping

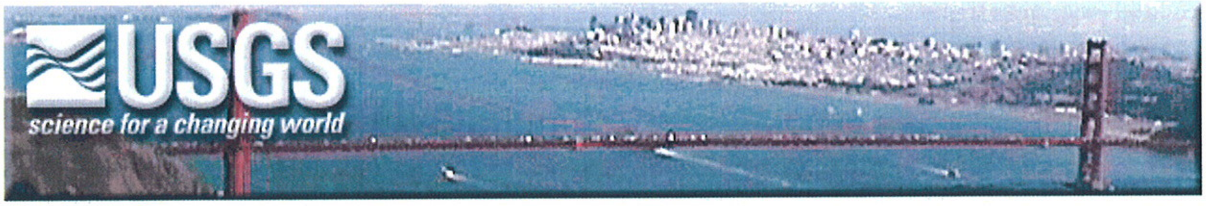
Fault Maps and other geological publications

- USGS Publications Warehouse
- Western Region USGS Publications
- California Geological Survey Publications

More information on San Francisco Bay region hazards

- USGS Earthquake Page
- USGS Northern California Earthquake Page
- Association of Bay Area Governments Earthquake and other hazards Page
- USGS Northern California Landslides
- San Francisco Museum 1906 Earthquake page
- Northern California Earthquake Data Center - Technical Data
- University of California Seismological Laboratory - Technical Data
- Additional USGS information about the San Francisco Bay region

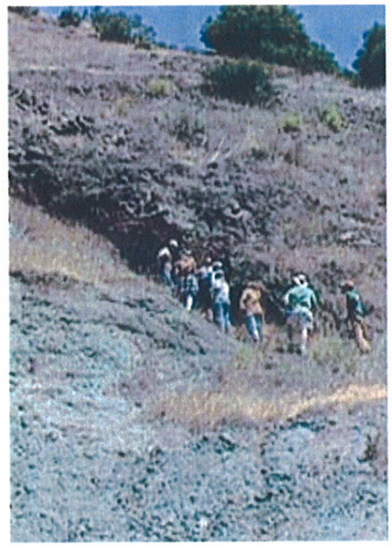
For more information about what you can do to prepare for future earthquakes, read *Putting Down Roots in Earthquake Country*.



San Francisco Bay Region Geology

The San Francisco Bay rcgion is underlain by some of the most complex and active geology in the world. The earth here is made up of everything from iron- and magnesium-rich rocks formed deep in the interior of our planet to sand and gravel recently deposited by our streams and rivers. All of these rocks are constantly being bent and tilted by the forces that also drive our San Andreas, Hayward, and other faults. The same forces that cause earthquakes have shaped the landscape that makes our region unique: the hills, the valleys, and the Bay itself. That landscape is still being formed, the Earth's forces driving hills and mountains up, rain and gravity dragging them back down, sometimes in massive landslides or dangerous flows of mud and debris.

This website provides a gateway to all kinds of information about the geology of the region, including geologic maps and paleontology (fossils), and links to other sites with even more information about marine geology, earthquakes, landslides, and more.

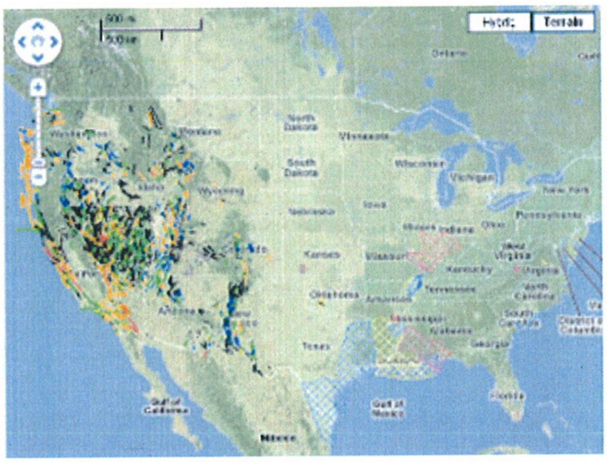


Above: Geologists examine the contact between the dark brown lava-rocks of the Moraga Volcanics (upper right) and the green-gray sandstone and conglomerate (pebbles and cobbles in sandstone) of the Orinda Formation at the east end of the Caldecott Tunnel between Oakland and Orinda. This contact formed about 10 million years ago when lava from a nearby volcano flowed into an ancient river valley and onto the sand and gravel of the riverbed.

Please send comments and suggestions to: rgraymer@usgs.gov
The URL of this page is /sfbay/
Updated: 16 January 2008

Earthquake Hazards Program

Quaternary Faults Web Mapping Application



Quaternary Faults Web Mapping Application

New web mapping application showing the Quaternary Faults that ar
the United States.

SHARE

USGS
science for a changing world

Earthquake Hazards Program

Quaternary Fault and Fold Database of the United States

Fault data updated 3 November 2010. If you use Google Earth or shapefiles, please download new files. Updates include relocation of faults in Idaho and Montana and correction of missing or incorrect attributes in the shapefiles.
Google Earth files
GIS Shapefiles

This website contains information on faults and associated folds in the United States that are believed to be **sources of M>6 earthquakes during the Quaternary (the past 1,600,000 years)**. Maps of these geologic structures are linked to detailed descriptions and references. Read our Factsheet for more information.

NOTE: This database is the source for faults used in the National Seismic Hazard Maps. The spatial representation of the faults in the hazard maps was simplified and critical fault parameters were assigned to produce the maps. To see the version of the faults used in the maps, go to the fault parameters section of the Hazard Maps website.

When using this data, please provide proper acknowledgement.

SHARE

San Andreas fault zone, Carrizo Plains, c
California. Photo by R.E. Wallace, USGS